Editorial

Early biology: the critical years for learning

Sue Dale Tunnicliffe[a] and Catherine Ueckert[b]

[a]Institute of Education, GEMS, London, UK; [b]Department of Biological Sciences, Northern Arizona University, Flagstaff AZ, USA

Biology education starts from birth. We have comparatively little research about this fundamental stage. The emphasis in the biology education world is very much on secondary-school pupils on later concept and skills development, whose knowledge is based on the early foundation in pre-school and primary school. The research emphasis is also on assessment and formal curricula.

Learning begins with talking. Talking is the precursor of reading and writing. At the foundations of learning biology we need to be encouraging observations and narratives about the living world that children encounter and planning such experiences for young children. The starting point for biology is observation. Children are intuitive scientists (Gopnik 2009). They observe, find patterns, hypothesise and try out ideas.

> Children, we now know, need to talk, and to experience a rich diet of spoken language in order to think and learn. Reading, writing and number may be acknowledged as curriculum 'basics' but talk is the true foundation for teaching. (Alexander 2008, 9)

Narratives are important in learning science. Ogborn et al. (1996) argue that science knowledge can be reworked into story-like forms, not merely to add to its 'liveliness' or 'interest', and not merely to show it 'applied' to some real context, but more fundamentally to act as an involving, memorable and efficient knowledge carrier:

- A narrative produced verbally when a child is asked to tell the story of whatever.
- Child spontaneously tells the story as they see it.
- Children develop a dialogue with a peer or adult at the child's instigation.
- Dialogue ensues after a prompt from a 'significant other'.

The dilemma of biology teaching is as follows: a child's learning is measured by success on a mandated state exam, and they learn the 'word' that will get the mark. They do not understand the fundamental concept and ideas that the 'word' represents. The emphasis on testing has forced teachers to focus on 'how to' rather than 'what does this mean'.

What is the answer to this dilemma? We need research to learn how concept understandings develop.

If pupils are to connect ideas and develop deep understandings over time, it is essential that learning goals are coherent and that they emphasise connections within and across subject areas and grades. In biology we still have much to learn about how early ideas are constructed, particularly about naming and categorising – the basis of biological communication.

The small amount of research about children's knowledge of plants and animals shows that children have an everyday knowledge, vocabulary and taxonomy about living things. We should learn more about early learning of biology. We should note what the child and peer groups observe.

Children may not have the vocabulary to communicate their observations and experiences or they may misunderstand the words used. For instance, a group of four-year-olds interviewed about plants only knew the word as a verb learned from experiences in pre-school when they planted seeds (Tunnicliffe forthcoming). They did not understand that the seeds were part of the plants and plants are green.

Experiences inside and outside that children have are important in developing their understanding of their environment and hence biology. Children, in our experience, enjoy collecting biofacts and artifacts which they encounter in their environment. For

Corresponding author: Sue Dale Tunnicliffe. Email: s.tunnicliffe@ioe.ac.uk

Journal of Biological Education ISSN 0021–9266 print/ISSN 2157–6009 online © 2011 Society of Biology
http://www.tandfonline.com
http://dx.doi.org/10.1080/00219266.2010.548873

example, a four-year-old boy, out with his parents, was observed collecting so many pine cones to the point that he could not carry them all in his hands. He had to make a decision. Which to retain and which to discard? He considered his dilemma. His solution was to identify some distinguishing attributes. These he decided where size, texture, and a certain shape. He eliminated cones which did not match his criteria. The result was a manageable collection. However, his father used this opportunity to introduce a new idea. What was the source of the pine cones? The child looked around him, considered, and then postulated that they had fallen from the trees. The father suggested that if he planted a pine cone, it would grow into trees. It is important that children direct their own learning even when the child is very young (Beauchamp 2010). As children process information and relate it to what they know and have experienced, they are becoming more aware of what can be found in their environment and the roles they play (Ueckert forthcoming; Driver et al. 1994).

Those who interact with children, from the earliest years, could be assisting them to develop their skills in observation, looking with meaning and accuracy rather than merely seeing. Guided science experiences outside of the formal classroom require children to think critically and to value their own experiences and ideas.

Young children use the appearance of an animal or plant to classify it and use exemplars, matching what they see with what they have experienced previously. They come to realise that the object represents a natural kind and thus the object has certain shared characteristics with other members of the same group and, therefore, shares membership. Much biology development is informal, with children learning from the world around them and not from formal teaching, and this creates conceptual problems as biological understandings (as other areas of science) are not always intuitive.

Another big problem occurs when children meet formal education. While teachers feel comfortable with biology (as compared with other areas of science), their knowledge can be more fragile than they realise. Upon visiting many primary elementary schools for the purpose of inspection or advising and working with people already in teaching situations with early years, we observe that a great many do not possess a grasp of the holistic concepts – the big pictures of biology. Thus, major concepts such as photosynthesis, metamorphosis, new life and parental care, are inadequately explained as core ideas and are thus likely to be problematic later in children's development because they are so misunderstood by teachers themselves in early years. Teaching 'bytes' of information without a linking of ideas can lead children to alternative conceptions – even the curriculum guidance implies that plants need sun, water and soil to grow and do not even mention air (Driver et al. 1994).

There are three main steps in acquiring hierarchical names:

1. Consider the spatial configuration of the objects as well as their perceptual similarities and unite them into 'graphic collections', and several collections are juxtaposed.
2. Non-graphic collections are formed by children and show features of classification but no inclusion, hence all members of a subordinate class are not recognised as belonging to their super-ordinate category.
3. True hierarchical classification skills require the classifier to use abstract thought and involve embedded knowledge.

There are complexities in this learning. Animals do not always have the same form during their life cycles. When this occurs in complete metamorphosis, it presents difficulties to children who identify the larva and adult as separate animal kinds. The learner thus has to learn to recognise identity class members, *eg* the stages of the different forms that an animal may assume during its life, as well as the different members of the species to which it belongs. They have to recognise equivalence categories, *eg* different kinds of frogs in the frog category (Bruner, Goodnow, and Austin 1956) and according to Piaget and Inhelder (1969) cannot do this until around 10 years of age.

Through dialogic talk, to the self or to a person, an early learner may link existing concepts to something they know, thus increasing their cognitive development in that area. Analysis of the personal narrative of a child about an observed biological phenomenon can reveal such accommodation and development as well as points which can be clarified with them through teaching.

'Children develop ideas about natural phenomenal before they are taught science in school' (Driver et al. 1994). We put it to you that this area of early years biology learning, emergent biology, is that upon which the assessment and curricula issues of later formal schooling are based and that we should be endorsing and encouraging more research to further our understanding about the development of biological understanding in young children and its implications for teaching.

References

Alexander, R. 2008. *Towards dialogic teaching: Rethinking classroom talk*. Cambridge, MA: Dialogos.

Beauchamp, G. 2010. Knowledge and understanding of the world. In *The early years foundation stage: Theory and practice*, ed. L. Palaiologou, 167–77. London: SAGE.

Bruner, J.S., J.J. Goodnow, and G.A. Austin. 1956. *A study of thinking*. New York: John Wiley.

Driver, R., A. Squires, P. Rushworth, and V. Wood-Robinson. 1994. *Making sense of secondary science: Research into children's ideas*. London: Routledge.

Gopnik, A. 2009. *The philosophical baby: What children's minds tell us about truth, love, and the meaning of life*. New York: Farrar, Straus and Giroux.

Ogborn, J., G. Kress, I. Martins, and K. McGillicuddy. 1996. *Explaining science in the classroom*. Buckingham, UK: Open University Press.

Piaget, J., and B. Inhelder. 1969. *The psychology of the child*. London: Routledge and Kegan Paul.

Tunnicliffe, S.D. Forthcoming. *Young children's understanding of plants*.

Ueckert, C. Forthcoming. *Enhancing student learning using community resources*.